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HAZARD EVALUATION

Development Organization Activities in Buildings 9202, 9203, 9205, and 9731

ADDENDUM FOR SENSITIVE MATERIALS (U)

December 1998

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LOCKHEED MARTIN ENERGY SYSTEMS, INC.
For the
U.S. Department of Energy
Under Contract DE-AC05-84OR21400

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Enclosure 1
Felton to Spence
December 22, 1998

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Y/DA 9469-A
Revision 0

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Y/DA 9469-A

Revision 0

APPROVALS

HAZARD EVALUATION
Development Organization Activities in Buildings 9202, 9203, 9205, and 9731

ADDENDUM FOR SENSITIVE MATERIALS (U)

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R. J. Spence Y-12 Site Manager, U.S. Department of Energy	12/23/98 Date

CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

ACN	acetonitrile
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
Energy Systems	Lockheed Martin Energy Systems, Inc.
EPA	U.S. Environmental Protection Agency
ERPG	emergency response planning guideline
IDLH	immediately dangerous to life and health
MSDS	material safety data sheet
NFPA	National Fire Protection Agency
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration

b-(3)

UNITS OF MEASURE

G	acceleration due to gravity
kg	kilogram
lb	pound
m	meters
mg	milligram
ppm	parts per million
s	second

EXECUTIVE SUMMARY

This document has been prepared as an addendum to an existing hazard evaluation report in order to document the hazard evaluation of the sensitive materials present in Development Organization facilities. As part of the research and development mission, Development Organization activities may involve the use and storage of sensitive materials which may or may not be hazardous, but for reasons of national or physical security cannot be listed in the hazard evaluation report which has an unrestricted distribution. The hazard evaluation in this addendum showed that the sensitive materials would be considered hazards most appropriately controlled by consensus codes, standards, and practices. The potential hazard exposure consequences could result only in localized injuries in the work area and are typical of hazard exposures found in general industry. The principal means of limiting hazard exposure to a local on-site area is administrative inventory control; however, additional quantitative analysis was provided for completeness. Protective features are provided in depth for on-site and work area safety. Results of the analysis indicate that, subject to the hazardous material inventory controls defined in this hazard evaluation, the Development Organization activities in the four facilities are within the Radiological and Low facility hazard classifications.

1. INTRODUCTION

A hazard evaluation, *Hazard Evaluation for Development Organization Activities* (Ref. 1), Y/DA 9469*, has been prepared for four facilities operated by the Development Organization of the Oak Ridge Y-12 Plant (Y-12 Plant) in Oak Ridge, Tennessee. The hazard evaluation showed that all Development Organization activity hazards would be considered adequately controlled by consensus codes, standards, and procedures. The potential hazard exposure consequences could result only in localized injuries in the work area and are typical of hazard exposures found in general industry. For the hazard types of radioactive materials and toxic materials, the principal means of limiting hazard exposure to a local on-site area is administrative inventory control; for these hazards, additional quantitative analysis was provided for completeness. Protective features are provided in depth for on-site and work area safety. Results of the analysis indicate that, subject to the hazardous material inventory controls defined in that hazard evaluation, the Development Organization activities in the four facilities are within the Radiological facility hazard classification for nonnuclear facilities as defined by DOE Standard DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (Ref. 2) and within the Low facility hazard classification for hazardous material facilities as defined by DOE Order 5481.1B, *Safety Analysis and Review System* (Ref. 3).

[redacted] b(3)

[redacted]. The analytical methodology and background information for the hazard evaluation of this material have been provided in Y/DA 9469; readers desiring more than the outline information provided in this addendum should consult that report.

* to be approved; during the interim, compensatory safety measures have been applied.

2. FACILITY DESCRIPTION

2.1 INTRODUCTION

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In general, the material may be present in a research laboratory at the Building 9202 Complex or the Building 9203 Complex. The largest quantity of the material will be present in prototype materials processing equipment at the special materials development area of Building 9731. This pilot-scale chemical purification process is a fully enclosed system located in two rooms of the first floor of the south bay area.

2.2 REQUIREMENTS

Since the Development Organization facility areas are not classified as "Nuclear," the required facility design codes, standards, and regulations are those promulgated in the applicable portions of the Energy Systems *Standards/Requirements Identification Document* (Ref. 4). These requirements are implemented by the Development Organization management in accordance with site-wide Y-12 Plant integrated safety management programs described in Chapter 5 of Y/DA 9469.

2.3 FACILITY OVERVIEWS

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2.4 FACILITY STRUCTURES

b (3)

2.5 PROCESS DESCRIPTION

2.5.1 Process Overview

b (3)

b(3)

The equipment has piped nitrogen, coolant (70% water/30% ethylene glycol), hot water, and electrical utilities.

2.5.2 Operations/Activities

The following activities performed in the pilot-scale special material development area can be performed independently or in any combination. Material can be introduced prior to any activity and subsequent operations can be performed in any order.

b(3)

When it has been determined that the ACN can no longer be used for purification, it is transferred out of the recrystallization system into a drum. This ACN is either disposed as waste, stored pending solvent purification, or purified in an evaporator. After evaporation, the purified ACN is either stored pending return to the recrystallization system or transferred directly into the recrystallization system.

Because the inventory quantities of the two hazardous materials in the special materials development area are controlled administratively, the potential hazard exposure consequences could result only in localized injuries in the work area and are typical of hazard exposures found in general industry. b(3)

For both types of exposures, research workforce personnel evacuate the immediate area and alert workers in other areas of the building. Protective features are provided in depth for work area safety. As an example, the ACN evaporator (essentially a modern laboratory still) is designed with typical laboratory redundant temperature control components and is vented through the condenser to atmosphere to prevent overpressure of the subsystem components as a result of overheating. As a result, it is highly unlikely that a single failure in the subsystem can allow the temperature of the ACN to exceed its boiling point of 82° C (180° F). The evaporator under a continuous nitrogen purge and vented to the atmosphere, cannot reach a temperature range at which hydrogen cyanide can be produced by the decomposition of ACN. The decomposition of ACN is just thermodynamically favorable above 700° C (Y-2238, *Properties of a Chemical Compound that Relate to Health and Safety (U)* (Ref. 5)). In addition to these subsystem safety features, the evaporator area is diked, the room electrical systems are designed for service in spilled flammable vapor environments, and the area ventilation is sized to mitigate leaks and small spills (Sect. 3.3.6).

2.6 CONFINEMENT SYSTEMS

Only limited amounts of dispersible hazards are present in these Development Organization facilities. A release of these materials in a work area would result in a localized health threat, a precautionary evacuation of the work area, and area cleanup activities by supervised personnel wearing personal protective equipment. Accordingly, the organization facilities do not have confinement systems. The facilities, do, however, have extensive provisions for contamination control as required by the plant safety practices described in Chapter 5 of Y/DA 9469. These provisions are typical of any modern industrial laboratory and include the use of fume exhaust hoods, marked contamination control areas, special localized ventilation systems with humidity control or HEPA filtration, and, in some cases, gloveboxes. In addition, administrative controls requiring the use of fitted respiratory protection and maintenance work permitting are used. The primary intent of these safety-related provisions is that of maintaining workforce exposures to airborne concentrations of hazardous and radioactive material contamination below as low as reasonably achievable (ALARA) levels. By restricting hazardous and radioactive material contamination to only that limited volume necessary to perform tests and experimentation, the use of these safety-related provisions results in avoidance of the expense of constant cleanup and surveillance of large contaminated work areas and the unnecessary hazard of large accumulations of unpackaged dispersible materials.

The contamination control provisions used in the Development Organization activities, such as those in the special materials development area, are not permanent, but will be installed, removed, and modified as required for a particular experiment or test. As a result, such provisions may be found at work area locations that no longer have hazards requiring such provisions; or, expensive items of equipment such as gloveboxes and chemical fume exhaust hoods will be left in place or stored for future use. In addition, gloveboxes and hoods may also be present in the work area for the purpose of experiment cleanliness. That is, the glovebox or hood may be used to prevent the exposure of experimental materials to contaminants present in ambient laboratory air, rather than used for safety-related purposes.

2.7 SAFETY SUPPORT SYSTEMS

As will be shown in Chapter 3, the use of hazardous material inventory control results in potential hazard exposure consequences best characterized as localized injuries in the work area, typical of hazard exposures found in general industry. Accordingly, the general safety support systems of interest in the hazard and accident analysis for Development Organization facilities are the building automatic fire protection systems, which either extinguish localized laboratory and test area fires or suppress such fires until the plant fire department personnel and equipment can respond to the fire alarm. No credit for the presence of these systems is assumed in the hazard and accident analysis; nevertheless, these systems are part of an extensive defense-in-depth approach to on-site and work area safety from uncontrolled fire events. Further descriptions of the elements of the defense-in-depth approach are presented in Section 3.3.6.

3. HAZARD ANALYSIS

b(3)

The objective of that hazard evaluation was to systematically identify and assess the hazards present in the Development Organization facilities and to evaluate the potential events that can cause the identified hazards to develop into accidents. The relative risk of each accident scenario was determined and the controls that act to prevent, detect, or mitigate each accident were assessed to determine the adequacy of facility safety provisions.

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3.1 HAZARD IDENTIFICATION

Hazard identification involves a systematic identification of the hazardous materials and/or energy sources associated with the facilities that can affect the public and/or the workforce.

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The largest quantity of the material will be present in the special materials development area at Building 9731.

b(3)

The screen-out measure quantities and comparison of the special materials development area activity hazards to the preliminary hazard screening criteria are provided in Table 3.1. Hazards identified as being above the screening criteria are reviewed further in Sect. 3.3.

Table 3.1. Preliminary hazard screening matrix, Special Materials Development Area

Hazard type	Summary description if present in facility	Measure quantity	Above measure quantity?
Radioactive materials	None present in immediate area.	Any isotope meeting or exceeding the Table A-1, DOE-STD-1027-92 TQ criteria; or exceeding the Appendix B, 40 *CFR* 302 RQ criteria. The inventory/RQ or inventory/TQ ratios are added.	No
Radioactive surface contamination	Residual contamination in sealed flooring.	Measurements of fixed, removable, or both exceed threshold quantity values in 10 *CFR* 835.	Yes
Radioactive wastes	None present in immediate area.	More than 0.002 microcurie per gram of waste.	No
Toxic materials	Small amounts of toxic materials in pilot scale operations.	Any toxic chemical or combustion products exceeding the RQ from Table 302.4, 40 *CFR* 302, or any other known toxic material (e.g., the NIOSH listing has an IDLH value).	Yes[1]
Carcinogens	None present in immediate area.	Any known carcinogen exceeding the RQ from Table 302.4, 40 *CFR* 302, or any other known carcinogen if not treated as a toxic material.	No
Biohazards	None present.	Any known biohazard for which special controls are required.	No
Asphyxiants	Piped nitrogen utilities in pilot scale operations.	Any asphyxiant that could affect either a large number of people or any unsuspecting people.	Yes
Flammable materials	Small amounts of flammable liquids in pilot scale operations.	More than 5000 lb of a liquid with a flash point less than 100°F, or more than 3000 standard ft^3 of a gas with an established lower explosive limit.	No
Reactive materials	None present in immediate area.	More than 10 lb of a substance with an NFPA reactivity hazard level of 2 or more.	No
Explosive materials	None present.	Any 49 *CFR* 173 division 1.1, 1.2, 1.3, material; or more than 10 oz of division 1.4 material.	No

Hazard type	Summary description if present in facility	Measure quantity	Above measure quantity?
Incompatible chemical reaction products	None present in immediate area.	More than 1 kg of two or more incompatible chemicals listed in ES/CSET 2A, Appendix G in the same area.	No
Electrical energy	None present in immediate area.	Unusual applications not adequately controlled by OSHA; a system voltage of 800 V or more and 24 mA or more output; or stored energy exceeding 50 J at 600 V or more.	No
Kinetic energy	None present.	High energy (e.g., flywheel or centrifuge type equipment).	No
High pressure	None present in immediate area.	More than 3000 psig or more than 0.1 lb TNT equivalent energy.	No
Lasers	None present.	Any Class IV or Class III with non-enclosed beam per ANSI Z-136.1.	No
Potential energy	None present in immediate area.	Elevated mass with "high" potential energy.	No
Accelerators	None present.	If documentation per DOE Order 5480.25 required.	No
X-ray machines	None present.	Any not meeting ANSI N537/NBS123 requirements.	No
Other: thermal energy	None present.	If the hazard can result in an unacceptable situation or by-product.	No

[1] Hazards exceeding these measure quantity criteria are not present.

CFR - *Code of Federal Regulations*
NIOSH - National Institute for Occupational Safety and Health
NFPA - National Fire Protection Agency
OSHA - Occupational Safety and Health Administration

b(3)

3.2. HAZARD CLASSIFICATION

Hazard classification provides a relative ranking of the facilities in terms of the potential unmitigated consequences of accidents involving the hazards that are identified. Development Organization facility activities may involve both radiological and chemical hazards. Therefore, a Radiological facility hazard classification has been established in accordance with DOE-STD-1027-92 (Ref. 2), and the facilities will be operated within a Low facility hazard classification as defined in DOE Order 5481.1B (Ref. 3).

3.2.1 Radiological Hazards

b(3)

3.2.2 Nonradiological Hazards

Based on mission and programmatic need, the Development Organization facilities will be operated as Radiological facilities with dispersible nonradiological hazard inventories maintained below the threshold quantities listed in 40 *CFR* 355, 40 *CFR* 68, and 29 *CFR* 1910.119. To provide a practical facility safety authorization basis envelope for nonradiological hazards, bounding inventory control values have been established for the more toxic materials. b(3)

identification of the ERPG-2 equivalent is presented in Sect. 3.3.2.1.) (A detailed discussion of the (X/Q) for Y-12 Plant weather conditions was assumed for ease of calculation. A conservative dispersion factor exposure time of 300 s was assumed. A bounding inventory control value was calculated with which to compare actual material at risk of dispersion under accident conditions in the Development Organization facilities. b(3)

verification calculation is detailed in Y/DA 9470-A, *Accident Analysis for Development Organization Activities—Addendum for Sensitive Materials* (U) (Ref. 6). The hazard classification

3.3 HAZARD SCREENING EVALUATION

The hazard evaluation process results in identification of potential accidents involving the identified hazards and their consequences. A qualitative hazard consequence evaluation methodology was used to review those hazards that were found to exceed the hazard screening criteria during the hazard identification exercise.

3.3.1 Qualitative Evaluation

Hazards that, by inspection, were determined to be common to general industry and the public; adequately controlled by consensus codes, standards, and procedures; or otherwise insignificant were in general eliminated from consideration in the preliminary hazard analysis exercise without further analysis.

For the nondispersible hazard types, the principal rationale for this ranking was that the potential hazard exposure consequences could result only in localized injuries in the work area and were typical of hazard exposures found in general industry or adequately controlled by meeting national standards, and best industry consensus codes and procedures. This same hazard screening evaluation methodology documented in Y/DA 9469 was used to evaluate the hazards identified for the special materials development area of Building 9731 in Table 3.1. The nondispersible hazard types in this area would be adequately controlled by meeting national standards, and best industry consensus codes and procedures. The potential hazard exposure consequences could result only in localized injuries in the work area and are typical of hazard exposures found in general industry.

For the dispersible hazard types, the principal rationale documented in Y/DA 9469 was that the amount of hazardous material present in a particular activity was typically so low that, again, the potential hazard exposure consequences could result only in localized injuries in the work area and were typical of hazard exposures found in commercial laboratory and testing facilities. Development Organization activities are not production activities and do not have a need for bulk feed stocks, in-process materials, or product storage. For the few cases of toxic materials present in the work area in amounts greater than screening criteria, a quantitative evaluation was performed. Since the principal means of controlling hazard exposure with these materials is administrative inventory control, the quantitative evaluation also provides the basis for bounding inventory control values. b(3)

3.3.2 Quantitative Evaluation

Before a quantitative evaluation can be preformed for a toxic material, information about its relative toxicity is required. b(3)

3.3.2.1 Toxicity

Because the physical mechanism by which a chemical can affect the body differs by material, by material form, and by exposure type, several ranking systems exist for chemical toxicity. These ranking systems are not all inclusive and depend upon the exposure of concern to the agency making the ranking. Energy Systems uses two preliminary hazard screening mechanisms: the values specified in 40 *CFR* 302.4, Table 302.4, and the assignment of an IDLH value to a toxic material.

3.3.2.1.1 Toxicity of ACN

Table 302.4 Criteria. ACN is listed in 40 *CFR* 302.4 with a reportable quantity (RQ) value of 5000 lb. These are the values set as reportable quantities by the EPA for releases of the materials under any conditions. That is, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), release of a toxic material in a quantity below these values is not reportable. No specific hazard consequence is associated with these values; however, the values clearly represent a quantity threshold below which toxic materials are an insignificant uncontrolled hazard.

IDLH Criteria. ACN has an IDLH value of 855 mg/m^3 set by the National Institute for Occupational Safety and Health (NIOSH). This is an exposure level established for the immediate hazard from acute exposures. No irreversible effects are associated with exposures below an IDLH value; however, the IDLH value represents an exposure threshold above which toxic materials are expected to be an acute hazard after exposure for 30 min.

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3.3.2.2 Exposure under Accident Conditions

3.3.2.2.1 Exposure to ACN under Accident Conditions

ACN is a colorless liquid with an aromatic ether-like odor detectable at 40 ppm. It is slightly toxic by acute exposure through oral intake, skin contact, and inhalation. ACN is extremely irritating to the eyes and slightly irritating to the skin. It is miscible in water. It hydrolyzes on exposure to strong acids and bases, is violently reactive to strong oxidizers, and is incompatible with reducing agents and alkali metals.

Under liquid dispersion conditions caused by damage to the material containment, the primary health effects of exposure to the liquid would be those of exposure to a toxic material as an airborne aerosol. The accident analysis methodology described in Y/DA 9469 uses an equivalent emergency response planning guideline (ERPG-2) value as the starting point for calculating the allowable amount in a facility of a dispersible material at risk. Therefore, in this evaluation of the presence of ACN in Development Organization facilities, the equivalent ERPG-2 value (100.8 mg/m^3), is used where fire is not involved.

ACN is flammable at room temperature with a flash point of 6° C (42° F). Under fire conditions involving damage to the material containment and protective environment enclosures, the primary health effects of exposure (after the immediate effects of heat and flame) would be those of exposure to the smoke as an airborne aerosol. The exact smoke components of an open fire involving ACN are poorly documented, but the combustion products of an ACN fire can be expected to have transient hydrogen cyanide and NO_x components. Hydrogen cyanide has an equivalent ERPG-2 value of 11.2 mg/m^3, lower than that of ACN. The hydrogen cyanide that could be produced in an ACN fire would be a flammable gas with a flash point of -21° C (0° F); under the conditions of an uncontrolled fire, this byproduct would be consumed and the amount of hydrogen cyanide expected to be present downwind of the fire event would be insignificant. A fire condition in which significant hydrogen cyanide would be present in the smoke (controlled combustion with limited oxygen) is not likely to be present. The potential toxicity of hydrogen cyanide in the smoke from an uncontrolled fire involving ACN was reviewed during calculation of bounding inventory control values for the Development Organization facilities. Upon consideration, however, even if the toxic smoke component were assumed to be an aerosol of hydrogen cyanide rather than unburned ACN, the difference in toxicities between the two materials (a factor of nine), is insignificant within the known conservatism incorporated in the accident analysis methodology being used to calculate the bounding inventory control values. Therefore, using additional conservatism to model an unlikely occurrence is not justified. The equivalent ERPG-2 value for ACN (100.8 mg/m^3), is also used where fire is involved.

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[redacted]

3.3.2.3 Hazard Evaluation

b(3)

[redacted] As documented in Y/DA 9469, the preliminary hazard analysis (PHA) methodology was used to determine the bounding accident scenarios for Development Organization facilities: severe seismic events and uncontrolled fires. [redacted] b(3)

Summaries of each of these accident scenario evaluations are identified in the PHA summary sheets, Tables 3.2 and 3.3.

For the earthquake and fire accident scenarios, a bounding inventory control value at which a dispersion of each material would have a significant off-site impact was calculated. An ERPG-2 or equivalent was identified. For each scenario, a conservative containment damage ratio, airborne release fraction, respirable fraction, and leakpath factor were selected that corresponded to the assumed accident scenario characteristics. A conservative dispersion factor (X/Q) for Y-12 Plant weather conditions was assumed. A conservative exposure time of 300 s was assumed. [redacted] b(3)

No credit for prevention or mitigation of accident consequences was assumed in the PHA calculations; however, the accident scenario reviews clearly identified the points at which systems, structures, components, and controls would have a beneficial effect in accidents involving the hazardous materials. The bounding inventory control calculation is detailed in Y/DA 9470-A.

3.3.3 Hazard Evaluation Summary

[redacted] b(3)

By controlling the toxic material inventories so that potential accident exposures are below these levels, Development Organization personnel reduce these exposure hazards to a level that would be characterized as adequately controlled by consensus codes, standards, and procedures. Table 3.4 summarizes the results of the quantitative hazard evaluation for the special materials development area of Building 9731. b(3)

[redacted]

Table 3.2. Preliminary hazard analysis summary sheet—earthquake

Accident scenario		
Description		A seismic event with peak horizontal ground-level soil acceleration up to 0.11 G causes failure of the building containment and failure of portions of the hazardous material containments, partially releasing contents.
Initiating events		Earthquake
Applicable operating modes		Any
Hazards		1. Airborne radioactive particles. 2. Airborne toxic materials.
Controls		
Prevention	Design	None.
	Administrative	None.
Detection	Design	1. Regional seismic monitoring stations.
	Administrative	2. Operator observation.
Mitigation	Design	3. Primary containment provided by hazardous material packaging and equipment. 4. Building provides some secondary containment if not damaged. 5. Equipment enclosure provides secondary containment if not damaged. 6. Sprinklers extinguish subsequent fires if not damaged.
	Administrative	7. Limit on allowable hazardous material inventory. 8. Emergency preparedness program.
Frequency estimate		
Scenario annual probability		Unlikely ($10^{-2} \geq p > 10^{-4}$)

Consequence estimate		
	Hazard no.	
	1	2
Facility worker	N/A[1]	N/A[1]
On-site personnel	N/A[2]	N/A[2]
Off-site receptor	Low	Low

Risk assessment and evaluation of controls	
Risk category	2
Controls taken credit for	7
Additional design or operational changes required to reduce risk	None
Additional analysis required	None

1. Per NFPA-101, *Life Safety Code,* Section A.5-11.1, the facility worker is assumed to escape the immediate area without significant exposure to airborne materials.
2. Risk to other on-site personnel following natural phenomena accidents is dominated by the structural response of their own facility (see Table 3-3).

Table 3.3. Preliminary hazard analysis summary sheet—uncontrolled fire

Accident scenario		
Description		Hazardous materials spontaneously ignite or are burned in a fire caused by other accident initiation.
Initiating events		1. Introduction of prohibited materials. 2. Uncontrolled chemical/process reaction. 3. Spontaneous ignition or spread of other fire. 4. Operator errors or equipment failures.
Applicable operating modes		Any.
Hazards		1. Airborne radioactive particles. 2. Airborne toxic materials.
Controls		
Prevention	Design	1. Metal hazardous material containers minimize ignition. 2. Inert equipment environments minimize ignition. 3. Sprinkler systems prevent spread of fire. 4. Electrical equipment design minimizes ignition.
	Administrative	5. Fire prevention program minimizes amount of combustible material to prevent spread of fire.
Detection	Design	6. Sprinkler system.
	Administrative	7. Operator observation.
Mitigation	Design	8. Hand-held extinguishers. 9. Sprinkler systems. 10. Fire department.
	Administrative	11. Limit on allowable hazardous material inventory. 12. Fire protection program. 13. Emergency preparedness program.
Frequency estimate		
Scenario annual probability		Unlikely ($10^{-2} \geq p > 10^{-4}$)

Consequence estimate		
	Hazard no.	
	1	2
Facility worker	N/A[1]	N/A[1]
On-site personnel	Low	Low
Off-site receptor	Low	Low

Risk assessment and evaluation of controls	
Risk category	2
Controls taken credit for	11
Additional design or operational changes required to reduce risk	None.
Additional analysis required	None.

1. Per NFPA-101, *Life Safety Code*, Section A.5-11.1, the facility worker is assumed to escape the immediate area without significant exposure to airborne materials.

Table 3.4. Hazardous material characteristics in the special materials development area, Bldg. 9731

	OSHA PEL (mg/m^3)	NIOSH IDLH (mg/m^3)	EPA RQ (lb)	EPA TQ (lb)	OSHA PSM (lb)	AIHA ERPG-2 (mg/m^3)	Physical data	Inventory control value* (kg)
Acetonitrile	70	855	5000	—	—	100.8	MW: 41; VP: 73 mm; BP: 179°F; UEL: 16%; FIP: 42°F; LEL: 3%	6.4×10^2

*The inventory control value is based on maintaining the off-site exposure to a chemical below the ERPG-2 equivalent.

OSHA PEL - Occupational Safety and Health Administration permissible exposure limit value
NIOSH IDLH - National Institute of Occupational Safety and Health immediately dangerous to life or health value
EPA RQ - U.S. Environmental Protection Agency reportable quantity (for spill reporting)
EPA TQ - U.S. Environmental Protection Agency threshold quantity (for emergency planning)
OSHA PSM - Occupational Safety and Health Administration process safety management value
AIHA ERPG-2 - American Industrial Hygiene Association emergency response planning guideline level 2 or temporary emergency exposure limit level 2
MW - molecular weight VP - vapor pressure BP - boiling point MP - melting point
FIP - flash point UEL - upper explosive limit LEL - lower explosive limit

b(3)

[redacted] b(3)

At Building 9731, the National Fire Protection Association (NFPA) codes appropriate for the storage and processing of flammable solvents have been incorporated into the design of the development area. In addition, the protective environment enclosures used to maintain the quality of the material also act to prevent workplace exposure to the material.

3.3.4 Risk Assessment

Section 3.3.3.4 of Y/DA 9469 documents the assessment of the risk associated with activities conducted in the facilities of the Development Organization. [redacted] b(3) No scenarios of concern or major concern were identified. The only controls that act to prevent, detect, or mitigate an accident that were taken credit for in the risk assessment are the administrative controls on the amount of hazardous materials that may be present at Development Organization facilities. No credit has been taken in the risk assessment for facility structures, systems, and components (SSCs) to reduce the risk of operations. Therefore, no safety-class SSCs are associated with Development Organization facilities. Based on this assessment, the risks posed by Development Organization activities are acceptable provided the administrative controls discussed above are in place. No further representative or quantitative analyses are required.

The hazards associated with Development Organization activities can be characterized as those regulated by OSHA and found in general industry, adequately controlled by consensus codes, standards, and procedures. The risk of conducting research and development activities is controlled at the low consequence, low frequency of occurrence level using a combination of administrative inventory control, consensus codes, national standards, plant procedures, and best industry practices. [redacted] b(3) The Energy Systems integrated safety management programs which incorporate these codes, standards, procedures, and practices are shown in Chapter 5 of Y/DA 9469.

3.3.5 Planned Design and Operational Safety Improvements

As part of the integrated safety management program described in Chapter 5 of Y/DA 9469, planned design and operational safety improvements are made in research and development work areas using job hazard analysis. Based on the job hazard analysis and this hazard evaluation, no further design and operational safety improvements are planned.

3.3.6 Defense-in-Depth

Administrative controls on the type and amount of hazardous materials stored at Development Organization facilities provide the necessary and sufficient means of limiting off-site exposures. However, as noted in the PHA summary sheets, other controls are in place that act to prevent, detect, or mitigate an accident involving the hazardous materials. These other controls are designed primarily for research worker safety and provide defense-in-depth against exposures to spills or fires involving hazardous materials. It should be noted that the consensus design codes and standards have few specific requirements for situations involving limited quantities of hazardous materials in a small work area. For example, in the special materials development area in Bldg. 9731, only the NFPA National Electrical Code (NFPA 70), the NFPA standard (NFPA 30) for storage of flammable materials, and the NFPA standard (NFPA 496) for electrical cabinets in flammable materials areas apply. The work area electrical systems have been designed to comply with NFPA 70 and 496, and the ventilation system exceeds NFPA 30 requirements. These features prevent ignition of spilled flammable materials.

In addition to these consensus code and standard design requirements, however, the area has been systematically evaluated to reduce hazard exposure of workforce personnel in the event of spills and leaks . Both hazardous materials are moved and transported in strong, metal containers. The pilot-scale equipment items also act as durable metal containments to reduce the incidence of spills and leaks. The work area in which the solvent equipment items are located is diked to contain spills. Much of the equipment is located in inert environment glovebox enclosures to maintain chemical purity. These enclosures also act as a durable secondary containment to contain spills and leaks, and also act to maintain work area occupational exposure to hazardous materials at levels far below those generally found in typical industry. The work area is easily evacuated by two exits into the large three-story building bay in the event of spills or leaks.

In addition to the previously cited code and standard design requirements for fire prevention, the area has been systematically evaluated to reduce hazard exposure of research personnel in the event of fires. The combustible loading of the work area is maintained as low as reasonably achievable; the metal containers and pilot-scale equipment items which contain the hazardous materials prevent contact with external ignition sources. Temperature controls, utilized on the solvent evaporator for quality control, prevent overheating. The evaporator is vented to a nitrogen purge vent system, preventing overpressurization. Similarly, the heating system for the process, designed to maintain chemical quality, uses hot water, thus preventing overheating and generation of flammable gases. The nitrogen-purged equipment items, designed to maintain chemical quality, also act to prevent combustion of flammable and combustible materials. The building automatic sprinkler system provides fire mitigation coverage of the work area as well as automatic alarm annunciation both at Bldg. 9731 and at the plant fire department. An extension of the system provides internal glovebox sprinkler coverage. This glovebox sprinkler coverage is not required by a code or standard, but was installed as a prudent safety measure for defense-in-depth against worker exposures to fires involving hazardous materials.

3.3.7 Worker Safety

The numerous safety-related features detailed in Section 3.3.6 provide defense-in-depth to protect the research personnel from industrial hazard exposures of spills of toxic materials and fires involving flammable and combustible materials. The work area electrical systems in the special materials development area of Bldg. 9731 have been designed to comply with NFPA 70 and 496 requirements, and the ventilation system exceeds NFPA 30 requirements. These consensus code and standard requirements which prevent ignition of spilled flammable materials represent the minimum safety standards. The majority of the safety-related features detailed in Section 3.3.6, however, are the result of the integrated safety management programs utilized by Energy Systems to protect the facility worker; these result in the installation of safety-related features that are not required, but represent good safety design practice. In addition, integrated safety design practice utilizes features which maintain chemical quality to have a beneficial effect on worker safety. Operationally, research personnel are trained in specific precautions for operating the laboratory equipment, transferring the hazardous materials, and avoiding occupational injury. Standard laboratory protective equipment such as gloves and monogoggles are utilized under normal operating conditions. Specific training emphasizes the most important factor to maintain research worker safety under conditions of toxic material spills and work area fires, the evacuation of the work area and alert of workers in other areas of the building using fire alarms.

3.3.8 Environmental Protection

No accidents that would cause widespread environmental damage have been identified. However, the same administrative controls on the types and amounts of hazardous materials utilized at Development Organization facilities that have been established to protect the public also serve to protect the environment. Also, the controls summarized in Section 3.3.6 provide defense-in-depth and act to protect the environment from hazards. These features help ensure that facility activities will not adversely impact the environment and that consequences to the environment from accidents are minimized to the extent reasonably achievable.

4. SAFETY REQUIREMENTS

4.1 TECHNICAL/OPERATIONAL SAFETY REQUIREMENTS

The Development Organization facilities are controlled administratively to be within the facility hazard classification of Low for nonradiological hazards. Consequently, the facilities are not required to have technical safety requirements (TSRs) and none of the facility structures, systems, or components are designated as either safety class or safety significant. b (3)

4.2 SAFETY ANALYSIS ENVELOPE

Placement of the Development Organization facilities within the Radiological and Low facility hazard classifications is based on radiological and chemically hazardous material inventory control. The details of the administrative procedure used for hazardous materials inventory control are found in Y70-15-085, *Hazardous Materials Inventory Control in Development Organization Activities* (Ref. 7), and have been summarized in Sect. 4.3 of Y/DA 9469.

5. INTEGRATED SAFETY MANAGEMENT

[redacted] b(3)

ACN is also such a hazard. Energy Systems uses the plantwide safety management programs described in Chapter 5 of Y/DA 9469 to implement national consensus codes and standards for control of and protection from these types of hazards.

6. REFERENCES

1. *Hazard Evaluation for Development Organization Activities*, Y/DA 9469, Lockheed Martin Energy Systems, Inc., December 1998.

2. *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, U.S. Department of Energy, Washington, D.C., with Change Notice No. 1, September 1997.

3. *Safety Analysis and Review System*, DOE Order 5481.1B, U.S. Department of Energy, Washington, D.C., September 23, 1986.

4. *DOE Approved LMES Standards/Requirements Identification Document*, Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee, October 1997.

5. *Properties of a Chemical Compound that Relate to Health and Safety (U)*, Y-2238, W.K. Duerksen et al., Union Carbide Corporation Nuclear Division, Oak Ridge, Tennessee, September 29, 1981, p. 8.

6. *Accident Analysis for Development Organization Activities - Addendum for Sensitive Materials* (U), Y/DA 9470 - A, Design Analysis and Calculations, Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee, December 1998.

7. *Toxic Materials Inventory Control in Development Organization Activities*, Y70-15-085, Development Organization, Lockheed Martin Energy Systems, Inc., Oak Ridge, Tennessee, March 1998.

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